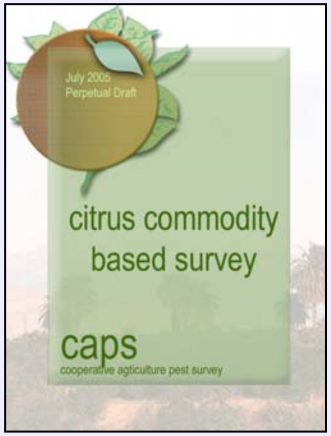
CPHST Support for the Commodity-Based Survey Paradigm

Melinda Sullivan & Laura Duffié

USDA APHIS PPQ CPHST

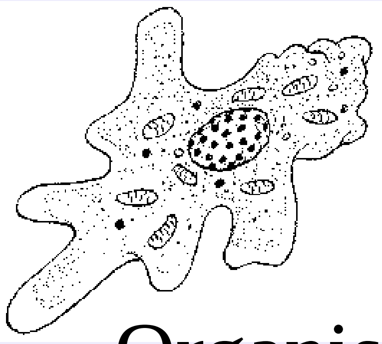


CPHST Survey tools

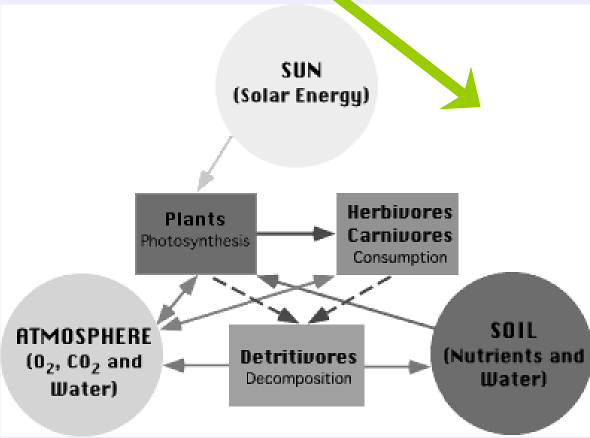
- National pest list- a prioritized pest list of high threat organisms on the national level
- Mini-pest risk assessments for key organisms on the national pest list
- NAPPFAST output for organisms of concern

FOCUS ON THE ORGANISM

Paradigm Shift



Organism



Systems Approach

Commodity-Based Deliverables

- Manuals
  - Citrus manual- Complete
  - Soybean manual – January completion
  - Forest Ecosystem manual – In process
  - Small Grain manual – Scheduled to begin in January
- Lucid Keys
  - Small Grains
  - Soybeans
- Statistical Survey Protocol
  - Soybeans – Scheduled to begin in January

Commodity-based survey manuals

- Synthesize pest information under the umbrella of a commodity
  - Include insects, mites, pathogens, nematodes, mollusks, and weed pests associated with a particular commodity
- Include exotic pests (all pest from national pest list, pests that did not make the national pest list), potential vectors, and endemic pests that are likely to be confused with the exotic pest.

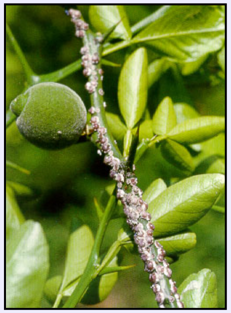



How did we select the commodities?

- National Pest list
- Information gathered about associated commodities of all pests on the national list.
- Commodities ranked based on the number of pests associated with them and their economic importance within the US.
  - The distribution of the commodity within the US was also considered.
- The top commodity and the first commodity-based survey manual selected for completion was citrus.

How did we determine what pests to examine in each manual?

- Pests on various pest lists were compiled and prioritized
  - National Pest Lists (all 141 pests, not just top 35)
  - Western and Eastern Region Pest Lists
  - Global Pest Disease Database
  - Emerging Plant Pest list
  - Regulated Plant Pest List
  - Other lists



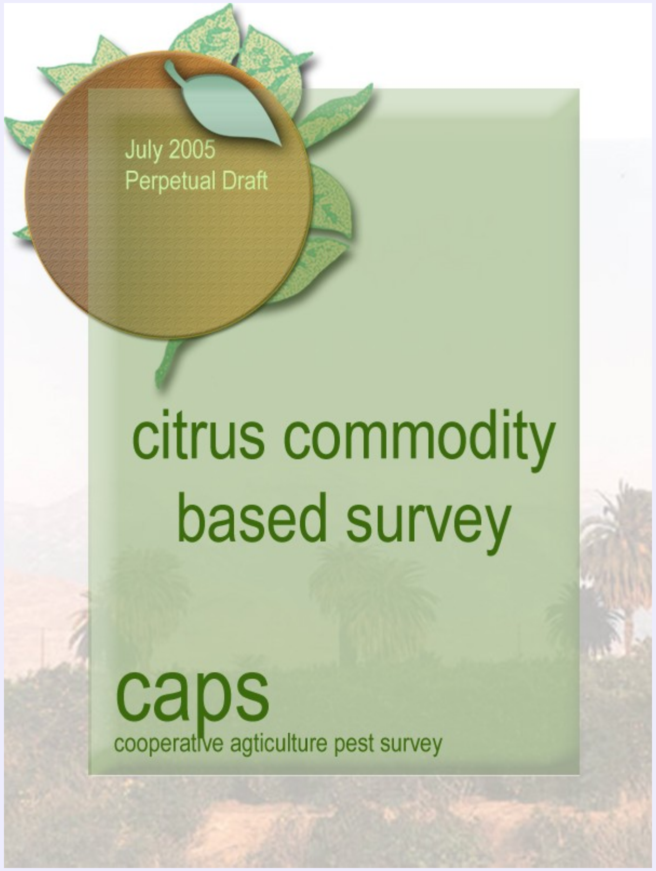
- Potential vectors and endemic pests that could be easily confused with exotic pests were also included as the manual was prepared.

What information is included on each pest?

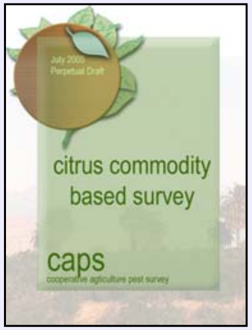
- Scientific names
- Synonyms
- Common Names
- Taxonomic Position
- Reason for inclusion in manual (i.e. which list)
- Pest description
- Pest importance
- Symptoms
- Known hosts
- Known distribution
- Potential distribution in US
- Survey info (if any available)
- Key diagostics
- Photos
- References

Citrus Commodity Based Survey Manual

- Started in late April 2005
- Completed in July 2005



Citrus Commodity Based Survey Manual



- Introduction
- 62 pest datasheets
  - 1 ant
  - 1 aphid
  - 3 beetles/weevils
  - 15 flies/whiteflies/fruit flies
  - 1 leafhopper
  - 3 mealybugs
  - 1 mite
  - 6 moths
  - 2 psyllids
  - 5 scale insects
  - 2 thrips
  - 4 bacterial diseases
  - 3 fungal diseases
  - 3 viral diseases
  - 7 nematodes
  - 3 parasitic plants/weeds
  - 2 mollusks
- Glossary
- Appendix (References)

Diseases

Bacterial/Mollicute Diseases

Liberobacter africanum, L. asisasticum

Scientific Name
Liberobacter africanum Monique Garnier, *Liberobacter asiaticum* Monique Garnier

Common Name(s)
Citrus greening, huanglongbing, yellow shoot disease, yellow branch disease, likubin, drooping disease, mottle leaf disease, citrus dieback, citrus phloem degeneration

Type of Pest
Plant pathogenic bacterium

Taxonomic Position
Phylum: Proteobacteria

Reason for inclusion in manual
National pest list, National select agent list, and Regulated plant pest list

Pest Description
Citrus greening is caused by the fastidious, phloem-limited Gram-negative bacteria, *Liberobacter africanum* in Africa and *Liberobacter asiaticum* in Asia. Despite many attempts, the citrus greening bacterium has not been grown in culture. Thus, the bacterium is often referred to as *Candidatus Liberobacter spp.* The Asian form of the bacterium is considered heat-tolerant and the African form is considered heat-sensitive. Symptoms are not displayed above 25 to 30 °C for the African form, whereas the Asian pathogen displays symptoms at temperatures above 30 °C. Symptoms are also more severe with Asian form.

Figure 1: Yellow shoots typical of citrus greening. Photo Courtesy of T.R. Gottwald and S.M. Garnsey

The disease is spread by vegetative propagation (grafting), experimentally by dodder (*Cuscuta spp.*) and by two phloem-feeding psyllid vectors. The Asian citrus psyllid, *Diaphorina citri* (Kuwayama) and the African citrus psyllid, *Trioza erytreae* (del

Guercio) vector the Asian and African species, respectively. Either of the two psyllid vectors have proven capable of hosting either pathogen in the laboratory, however, it is not known whether this occurs in nature (da Gracca, 1991). The disease is not seed transmitted.

The bacterium can be seen by electron microscopy in the sieve tubes of infected trees and in vectors as elongated sinuous rods, 0.15 to 0.25 μm in diameter. The bacterium's resistance to culture on artificial media has made study of the organism's population dynamics, epidemiology, and interactions with its psyllid vectors quite difficult.

In 2004, citrus greening disease was reported in the main citrus growing areas of Sao Paulo, Brazil. The bacteria from citrus leaves had 93.7% similarity with the Asian and African form of the citrus greening pathogen. In 2005, it was reported that the bacterium found in Sao Paulo was sufficiently different from known *Liberibacters* to warrant a new species named *Liberibacter americanus* (Colletta-Filho et al., 2004; Texeira et al., 2005.) The vector, *Diaphorina citri,* is endemic in Brazil.

Pest Importance

Citrus greening is thought to have originated in China in the early 1900's. Globally, greening has been regarded as one of the most important threats to commercial and sustainable citrus production. However, losses due to greening are not easy to assess. Sometimes only sectors of a tree are affected and losses are small, but in other cases the entire tree is infected and crop loss is total (de Graca, 1991). In some areas of the world where the disease is endemic, citrus trees decline within five years of planting and most never bear usable fruit. Such losses are significant, since profits are only attainable 8 to 10 years after planting. In countries where greening occurs, it is the primary limiting factor for citrus production. Citrus greening has a long incubation period and many latently infected citrus plants occur in the field (McClean, 1970). Plants may, therefore, be infected with citrus greening and not show symptoms. If latently infected plants are used in propagating, grafting, the disease is spread.

Figure 2: Close up of a yellow shoot
Photo Courtesy of R.F. Lee

Control measures are limited to the use of disease-free propagating stock, rouging of infected trees, and chemical or biological control of the vectors. The vector *D. citri* was found in Florida in 1988, in Texas in 2001, and has spread considerably since its introduction (Knapp et al., 2004; French, 2002). The presence of the vector in the United States and the recently reported outbreaks of citrus greening in Brazil raise concerns that any

Figure 3: Blotchy, mottled leaf
Photo Courtesy of R.F. Lee

unrecognized introduction of greening-infected citrus in the past and any future introduction of the pathogen could lead to spread and establishment of the disease by a vector now in place. Citrus greening disease was recently (September 2005) detected in Miami-Dade County, however, few details are available at this time.

Figure 4. Zinc deficiency symptoms on citrus. Photo courtesy of S. Futch

Symptoms

Citrus greening can be a systemic disease, especially in younger trees. The first visible symptom of greening is usually a single yellow shoot in the canopy, which gave rise to the Chinese name, huanglongbing, meaning "yellow shoot" (Fig. 1, 2). Characteristic of greening, however,it is that one branch or part of the tree first shows symptoms, which then progressively spreads throughout the tree canopy. As the disease progresses, trees turn chlorotic, develop twig dieback, and rapidly decline to a nonproductive state.

Figure 5 *Top:* Greening infected leaf with yellow vein symptom. *Bottom:* Healthy citrus leaf. Photo Courtesy of R.F. Lee

Affected leaves are blotchily mottled (Fig. 3), becoming pale yellow, or have the appearance of foliage affected by zinc and other nutrient deficiencies. Leaves with citrus greening have a mottle appearance that differs from nutrition-related mottling in that greening-induced mottling usually crosses leaf veins. Nutrition related mottles usually are found between or along leaf veins and leaves may be small and upright (Fig. 4). In leaves with citrus greening, the veins are often prominent and yellow (Fig. 5). The leaves often fall off prematurely.

Figure 6: Stylar end greening on mandarin orange fruit. Photo Courtesy of T.R. Gottwald and S.M. Garnsey

The fruit are usually small, misshapen, and are sour to bitter to the taste. This is in contrast to fruit affected with severe citrus tristeza virus (CTV), blight, or stubborn, where the fruit are sweet. The seeds within the fruit often are aborted. The fruit fails to color uniformly as it ripens (stylar end greening) (Fig. 6). On Mandarin orange, the fruit develop uneven ripening in such that they appear half orange and half green. This symptom is responsible for the common name 'greening' and primarily occurs with the African species and cool climates.

Known Hosts

Citrus greening is a disease of rutaceous plants. The citrus greening bacterium infects citrus generally (EPPO, 1988). The bacterium may persist and multiply in most *Citrus spp*. but most severe symptoms are found on oranges (*C. sinensis*), mandarins (*C. reticulata*), and tangelos (*C. reticulata* x *C. paradisi*). Somewhat less severe symptoms are found on lemons (*C. limon*), grapefruits (*C. paradisi*), *C. limonia*, *C. limmettioides*, rough lemons (*C. jambhiri*), kumquats (*Fortunella spp.)*, and citrons (*C. medica*). Symptoms are even weaker on limes (*C. aurantiifolia*) and pummelos (*C. grandis*). A range of other rutaceous plants including ornamentals and wild species are susceptible to infection; however the severity of symptoms displayed varies. **These hosts include: *Poncirus, Severinia buxifolia* (box thorn) *Lemonia acidissima, Murraya*, *Toddalia*, *Calodendrum capense*.** The citrus greening bacterium has been experimentally transmitted, by *Cuscuta campestris* (dodder) from citrus to one non-rutaceous host *Catharanthus roseus* (Garnier and Bove, 1983).

Known Distribution

Greening caused by *L. asiaticus* is found in many countries throughout Asia and is spreading in Indonesia. *L. africanus* occurs in numerous countries in Africa and is also spreading. Both *L. asiaticum* and *L. africanum* were present in Reunion and Mauritius, sometimes co-existing in the same tree (Garnier et al., 1996). The greening bacterium and its vectors have not been detected in Australia. *L. americanus* was detected in Brazil in 2004.

Asia: Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Phillipines, Saudi Arabia, Taiwan, Thailand, Vietnam, Yemen (EPPO, 1988).

Africa: Burundi, Cameroon, Central African Republic, Comoros, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Rwanda, Reunion, Somalia, South Africa, Swaziland, Tanzania, Zimbabwe.

South America: Brazil

Potential Distribution within the US

Areas within the United States with citrus production and temperatures from above 25 °C would be most at risk for greening disease. The African species of *Liberobacter* occurs only in cool climatic conditions (below 25 to 30 °C or 77 to 86 °F), at elevations above 600 to 1000 m where the primary vector *T. erytreae* is most numerous (Green and Catling, 1971). In contrast, the Asian species occurs at low elevations with a hot climate (above 30 °C or above 86 °F). The psyllid vector is *Diaphorina citri*. Among the environmental factors, strong wind seems most important (Koizumi et al., 1997). *D. citri* can fly but within a short range from leaf to leaf or twig to twig when observed in an incubator. A strong wind may disseminate the viruliferous psyllas from the donor to the receptor in a leeward direction, which enhances disease transmission (Koizumi et al., 1997).

In September 2005, the greening bacterium was detected in Miami-Dade County, Florida. Few details concerning the extent of the infection are available at this time.

Survey Procedure

Currently there are no specific survey methods for this disease. Greening is commonly identified in the field by foliage and fruit symptoms. A yellowing of the tree canopy, blotchy mottled leaves and small lopsided fruits with aborted seeds provide the best indication of citrus greening infection. Further diagnosis requires indexing on susceptible citrus seedlings by graft inoculation or confirmation through the use of DNA hybridization or polymerase chain reaction (PCR) to identify the bacterium.

Symptoms of greening disease also may be confused with stubborn disease (*Spiroplasma citri)*, citrus tristeza closterovirus (CTV) infection, *Phytophthora* infection, citrus blight, or certain nutrient deficiencies. This makes greening disease difficult to identify in the field. However, the yellow vein symptom combined with the bitter fruit is helpful to differentiate greening from citrus blight, CTV, and citrus stubborn.

The first visible symptom of greening is usually a single yellow shoot in the canopy, which then progressively spreads throughout the tree canopy. Initial survey efforts should focus on the tree canopy. If symptoms occur in the canopy, then the leaves and fruits should be examined for further symptoms.

Alternative hosts always play a role in an epidemic disease, but they are often neglected in epidemiological studies especially when they cannot be easily recognized. The greening bacterium can replicate in boxthorn (*Severinia buxifolia*) and wood apple (*Limonia acidissima*), but not in orange jasmine (*Murraya paniculata* var. *paniculata*) and curry leaf (*Murraya euchrestifolia*) (Hung et al., 2000). Boxthorn is a spinous shrub native in Florida. Orange jasmine and curry leaf are common hosts for the psyllid vectors, particularly *D. citri*, but not for the greening organism. These hosts should also be monitored for the bacterium and the vector during surveys, particularly if located in close proximity to a citrus producing area.

Key Diagnostics

The bacterium that causes citrus greening is difficult to detect because of its low concentration and uneven distribution in its natural hosts (da Graca, 1991). Fortunately, the application of DNA probes overcomes the difficulty of greening detection.

Vectors

Psyllids

Diaphorina citri

Scientific Name
Diaphorina citri Kuwayama

Synonyms:
Euphalerus citri

Common name(s)
Asian citrus psyllid, Asiatic citrus psyllid, oriental citrus psyllid

Type of Pest
Psyllid

Taxonomic Position
Class: Insecta, **Order:** Homoptera, **Family:** Psyllidae

Reason for inclusion in manual
Western Region pest list

Pest Description
The Asian citrus psyllid, *Diaphorina citri*, is similar to *Trioza erytreae*, the African citrus psyllid, which is the vector of citrus greening disease in Africa. The geographical range of the two species did not originally overlap, but they now occur together in Mauritius, Reunion and Saudi Arabia (CABI, 2004).

Figure 1. Eggs of *D. citri*. Photo courtesy of D. Caldwell.

Figure 2. Nymph of *D. citri*. Photo courtesy of University of Florida.

Eggs: The egg of *D. citri* is anchored on a slender stalk-like process arising from the plant tissue. It is elongate with a broad basal end and tapering towards its distal and curved end. The average size of the egg measures 0.31 mm long and 0.14 mm wide. Freshly deposited eggs are light yellow, and turn bright orange with two distinct red eye spots at maturity (Fig. 1) (CABI, 2004). Eggs are placed on plant tissue with long axis vertical to surface (long axis is horizontal to surface in *T. erytreae*) (Mead, 2002). Females lay more than 800 eggs during their lives.

Trioza erytreae

Scientific Name:
Trioza erytreae Del Guercio

Synonyms
Aleurodes erytreae, Spanioza eritreae, S. erythreae, S. erytreae, Spanioza merwei, T. citri, T. erythreae, T. merwei

Common Names
African citrus psyllid, African citrus psylla, citrus psylla (African), citrus psyllid (African), two-spotted citrus psyllid

Type of Pest
Psyllid

Taxonomic Position
Class: Insecta, **Order:** Hemiptera, **Family:** Triozidae

Reason for inclusion in manual
Western Region pest list

Pest Description
T. erytreae is similar to *Diaphorina citri*, the Asian citrus psyllid, which is the vector of citrus greening in Asia. The geographical range of the two species did not originally overlap, but they now occur together in Mauritius, Reunion and Saudi Arabia (CAB, 2004).

Eggs: Orange, cylindrical, with a sharp point anteriorly (Fig. 1); laid on leaf margins of young, actively growing foliage. Eggs are placed on plant tissue with long axis horizontall to surface (long axis is horizontal to surface in *D. citri*).

Figure 1. Eggs (left) and nymphs (right) of *T. erytreae*. Photo courtesy of EPPO.

Nymph: Dorso-ventrally compressed and varying in color from yellow, olive-green to dark grey; has a marginal fringe of white, waxy filaments; largely sedentary; forms distinct colonies and settles on the underside of young leaves, where, after a few days of feeding, it produces distinctive cup-shaped, open galls. Advanced nymphs of *T. erytreae* have two basal dark abdominal spots (Fig. 1).

Adult: Winged, pale and delicate initially, later becoming light brown. Males are smaller than females and have a blunt tip to the abdomen, the latter ending in a

May be confused with

Spiroplasma citri

Scientific Name
Spiroplasma citri

Common Names
Stubborn, citrus stubborn disease, little leaf (Israel), acorn disease.

Type of Pest
Plant pathogenic Mollicute

Taxonomy
Class: Mollicutes, **Family:** Spiroplasmataceae

Reason for inclusion in manual
Disease that could be confused with citrus greening

Pest Description
Saglio et al (1973) characterized the organism and proposed the name of *Spiroplasma citri*. It is chemo-organotrophic, facultative anaerobic, and has wall-less pleomorphic cells with a characteristic spiral morphology (Fig. 1). The minimum viable length of a helix is two turns (2.0μm x 0.1 to 0.2 μm). The helices are motile by flexing or rotation, apparently mediated by a contractile fibrillar cytoskeleton bound to the inner surface of the spiroplasmal membrane (Fig. 1). Some strains are non-motile and non-helical. *S. citri* is one of the very few plant pathogenic mollicutes that can be cultured (Saglio et al., 1973; Bradbury, 1991).

S. citri infects the phloem sieve tubes of its hosts. The pathogen persists in affected trees as they decline. It is in practice an obligate parasite, surviving in citrus or in a variety of other host plants. It is naturally transmitted by phloem sap-feeding leafhoppers: *Circulifer tenellus*, *Scaphytopius nitridus* and *S. acutus delongi* in California (Oldfield, 1988); and by *Neoaliturus haematoceps* and *C. tenellus* in the Mediterranean area (Bove, 1986; Klein et al., 1988). None of these vectors have a particular preference for citrus as a host, and it is likely that they acquire *S. citri* from other hosts. *S. citri* multiplies in its insect vectors, which become infective after 10 to 20 days of acquisition feeding (Liu et al., 1983). The insects can remain infective throughout their lives (which may be shortened by the infection), but there is no transovarial transmission.

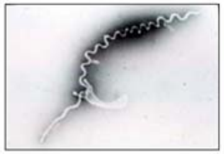


Figure 1. *Spiroplasma citri*. Note the spiral-helical nature of the organism as seen in the dark-field microscope. Photo Courtesy of EcoPort (http://www.ecoport.org)

Citrus tristeza closterovirus

Scientific Name
Citrus tristeza clostrovirus

Common Name
Tristeza, seedling yellows, quick decline, CTV

Type of Disease
Plant pathogenic virus

Reason for inclusion in manual
National pest list and Emerging plant pest list

Pest Description
CTV is a closterovirus with long flexuous particles (2000 x 11 nm in size) containing a non-segmented, positive-sense, single stranded RNA genome. It is phloem-limited virus.

Pest Importance
CTV is the most destructive viral disease of citrus and is not easily diagnosed. It is the most economically important pathogen of citrus worldwide. It has caused the death of infected trees of most citrus cultivars (except lemons) grafted on the highly susceptible sour orange rootstock. Millions of trees had been destroyed by the disease in the USA (> three million), Argentina (ten million), Brazil (> six million), and other countries. Thus, an accurate survey data on the distribution and incidence of CTV-infected trees are important for control efforts.

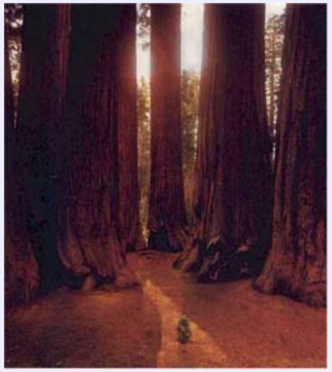
Symptoms
Symptoms are affected by the CTV isolate and environmental conditions. Most CTV isolates causes stunting, leaf cupping, vein clearing and chlorosis. Trees with a severe strain may quickly decline and die. Severe stem pitting or honeycomb in limes grapefruit, and sweet orange are often seen at the bark patch below the bud union. Fruits from infected trees are usually small and of poor quality. Characteristic symptoms are shown in Fig. 1.

Figure 1. Symptoms of citrus tristeza virus. Photo courtesy of T. Gottwald.

Soybean Manual

Stay Tuned… Completion scheduled for January

Forest Eco-Type



- Being conducted by Robert Venette (Forest Service)
- Currently working on eastern hardwoods.
- Next manual will focus on an eco-type from the western region.

Small Grains

- Scheduled to begin in January 2006
- New technician for Survey, Detection, and Inspection National Science Program

Where to access information?

- NAPIS website

http://www.ceris.purdue.edu/napis/

Questions/Comments

Melinda Sullivan

National Weed Management Laboratory

2301 Research Blvd., Suite 108

Ft. Collins, CO 80526

970-494-7518

melinda.j.sullivan@aphis.usda.gov

Commodity-Based Deliverables

- Manuals
  - Citrus manual- Complete
  - Soybean manual – January completion
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  - Soybeans
- Statistical Survey Protocol
  - Soybeans – Scheduled to begin in January

Commodity-Based LucID Keys

- Small Grains
- Soybeans

Questions/Comments

Terrence Walters

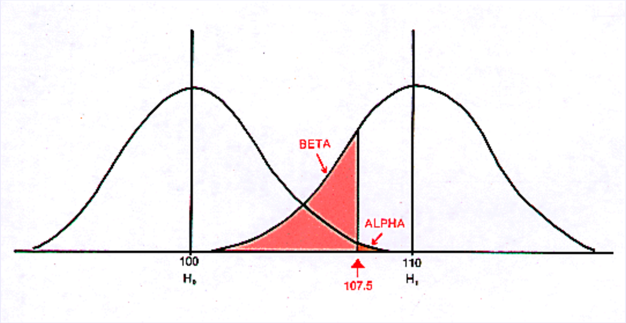
National Weed Management Laboratory

970-494-7518

terrence.w.walters@aphis.usda.gov

Statistical Survey Protocol:
Natural Extension of Survey Manuals

- Manuals: What am I looking for?
- Statistical Survey Protocols: How do I accomplish looking for these organisms?



Questions/Comments

Laura Duffie, Ned Jones, Kim Schwartzburg, Lynn Garrett

CPHST Director's Office, Raleigh, NC

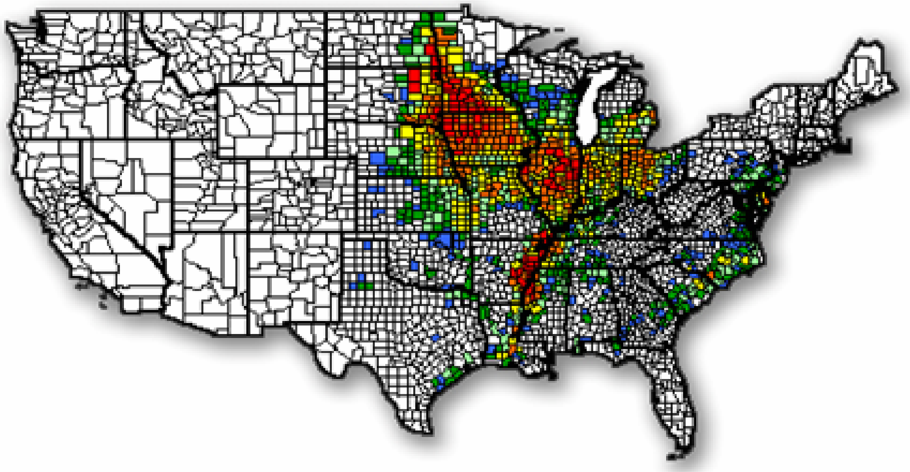
919-855-7420

laura.e.duffie@aphis.usda.gov

Statistical Survey Protocol:

Soybeans

Nationwide Soybean Production

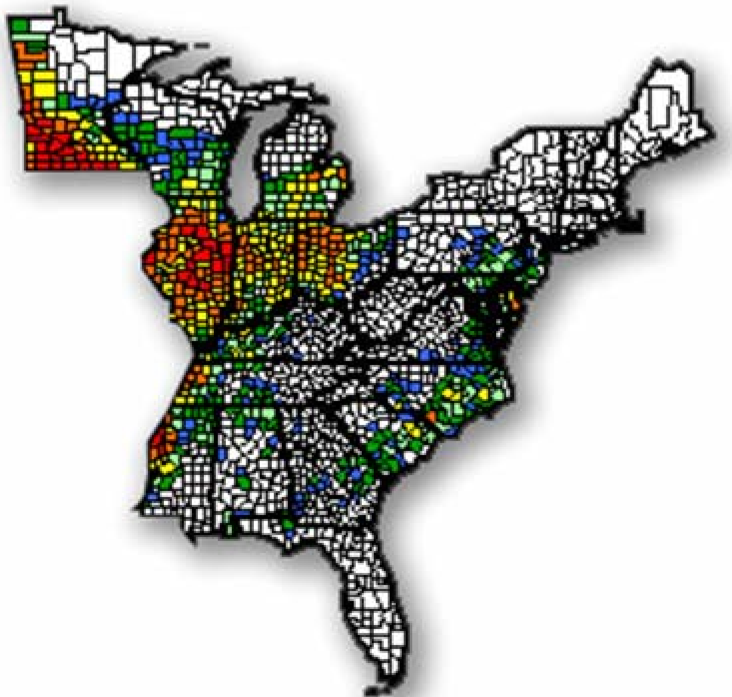


	Planted Area			Harvested Area		
	2002	2003	2004	2002	2003	2004
	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres
IL	10,600	10,300	9,950	10,550	10,260	9,900
IA	10,450	10,600	10,200	10,400	10,550	10,150
MN	7,200	7,500	7,300	7,100	7,450	7,050
IN	5,800	5,450	5,550	5,770	5,370	5,520
MO	5,050	5,000	5,000	5,000	4,950	4,960
OH	4,750	4,300	4,450	4,720	4,280	4,420
NE	4,700	4,550	4,800	4,580	4,500	4,750
SD	4,250	4,250	4,150	4,090	4,200	4,120
AR	2,950	2,920	3,200	2,880	2,890	3,150
KS	2,750	2,600	2,800	2,540	2,480	2,710
ND	2,670	3,150	3,750	2,630	3,050	3,570
MI	2,050	2,000	2,000	2,040	1,990	1,980
WI	1,540	1,720	1,600	1,520	1,670	1,550
MS	1,440	1,440	1,670	1,370	1,430	1,640
NC	1,370	1,450	1,530	1,290	1,400	1,500
KY	1,310	1,250	1,310	1,290	1,240	1,300
TN	1,160	1,150	1,210	1,120	1,120	1,180
LA	800	760	1,100	660	740	990
MD	490	435	500	470	430	495
VA	490	500	540	460	480	530
SC	435	430	540	415	420	530
PA	405	380	430	390	375	425
OK	280	270	320	260	245	290
TX	230	200	290	205	185	270
DE	190	180	210	185	178	208
AL	170	170	210	155	160	190
GA	160	190	280	140	180	270
NY	145	140	175	144	138	172
NJ	100	90	105	97	88	103
WV	18	16	19	17	15	18
FL	10	13	19	9	12	17
US	73,963	73,404	75,208	72,497	72,476	73,958

US 73,963 73,404 75,208 72,497 72,476 73,958

Soybeans for Beans: Area Planted and Harvested by State in Eastern Region 2002-2004

	Planted Area			Harvested Area		
	2002	2003	2004	2002	2003	2004
	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres
IL	10,600	10,300	9,950	10,550	10,260	9,900
MN	7,200	7,500	7,300	7,100	7,450	7,050
IN	5,800	5,450	5,550	5,770	5,370	5,520
OH	4,750	4,300	4,450	4,720	4,280	4,420
MI	2,050	2,000	2,000	2,040	1,990	1,980
WI	1,540	1,720	1,600	1,520	1,670	1,550
MS	1,440	1,440	1,670	1,370	1,430	1,640
NC	1,370	1,450	1,530	1,290	1,400	1,500
KY	1,310	1,250	1,310	1,290	1,240	1,300
TN	1,160	1,150	1,210	1,120	1,120	1,180
MD	490	435	500	470	430	495
VA	490	500	540	460	480	530
SC	435	430	540	415	420	530
PA	405	380	430	390	375	425
DE	190	180	210	185	178	208
AL	170	170	210	155	160	190
GA	160	190	280	140	180	270
NY	145	140	175	144	138	172
NJ	100	90	105	97	88	103
WV	18	16	19	17	15	18
FL	10	13	19	9	12	17
Total	39,833	39,104	39,598	39,252	38,686	38,998



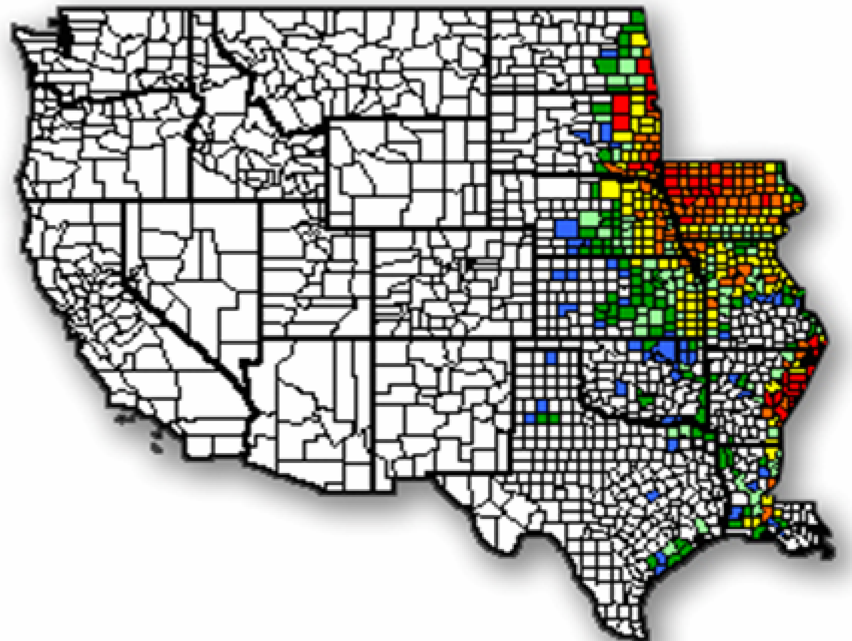
Eastern Region

Soybean Production

Total 39,833 39,104 39,598 39,252 38,686 38,998

Soybeans for Beans: Area Planted and Harvested by State in Western Region 2002-2004

	Planted Area			Harvested Area		
	2002	2003	2004	2002	2003	2004
	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres	1000 Acres
IA	10,450	10,600	10,200	10,400	10,550	10,150
MO	5,050	5,000	5,000	5,000	4,950	4,960
NE	4,700	4,550	4,800	4,580	4,500	4,750
SD	4,250	4,250	4,150	4,090	4,200	4,120
AR	2,950	2,920	3,200	2,880	2,890	3,150
KS	2,750	2,600	2,800	2,540	2,480	2,710
ND	2,670	3,150	3,750	2,630	3,050	3,570
LA	800	760	1,100	660	740	990
OK	280	270	320	260	245	290
TX	230	200	290	205	185	270
Total	34,130	34,300	35,610	33,245	33,790	34,960



Western Region Soybean Production

Total 34,130 34,300 35,610 33,245 33,790 34,960

Protocol Format

- Overview
- Big Picture versus Small Picture
- Target pests paired with best survey protocols
- Survey Methods (Traps, Visual Survey…)
- Confidence intervals versus economic return.

Underlying Themes

- Visual- Many photographs
- Tailored to the individual without being overly rigid.
- Build off of area wide surveys

How Can You Help?

- Communicate your needs to your SPHD and Regional Offices.
  - What Commodities are you interested in?
  - What confidence intervals will you need?